Tactile Technologies for VSW/SZ MCM Missions

A.H. Rupert, CAPT MC USN
Naval Aerospace Medical Research Laboratory
51 Hovey Road Pensacola, FL 32508-1046
Phone: (850) 452-4496 Fax: (850) 452-9290 E-mail: arupert@namrl.navy.mil

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http://www.namrl.navy.mil

LONG-TERM GOALS

The Navy currently lacks the capability to efficiently conduct very shallow water (VSW) mine countermeasures (MCM) operations. The VSW MCM Test Detachment was formed as the first measure to fill this critical gap. The ultimate goal is to achieve a fully autonomous UUV MCM capability. However, current and near-term MCM operations will continue to rely on the combined search skills of Explosive Ordnance Disposal (EOD) forces, marine mammals, and the combat swimmer and hydrographic reconnaissance skills of Naval Special Warfare and Marine Corps Reconnaissance forces.

OBJECTIVES

The objective is to improve the performance of the VSW MCM team members by improving the man-machine interface for the Integrated Navigation Sensor System (INSS now renamed HRLMD) for sub-surface operations and surface operations using the recently developed Tactile Situation Awareness System (TSAS) technology. Following enhancements based on the simulation and in-water testing, a prototype tactile display will be delivered to the VSW MCM detachment for further evaluation.

APPROACH

The Tactile Situation Awareness System tactile display will provide navigation information for the VSW MCM Test Detachment. The TSAS is a novel man-machine-interface consisting of three components: 1) Sensors, 2) Electronic Processor, and 3) Tactor Locator System (TLS). The TLS is composed of a strip of tactile transducers (tactors) held in close proximity to the torso and limbs of the body to provide tactile stimuli conveying information from navigation sensors. When properly integrated and presented, tactile information offers significant enhancements to personnel performance including covert/clandestine communications, freeing of the hands from holding displays, freeing the visual system for tasks other than reading instruments, and most importantly providing intuitive non-cognitive situation awareness.

The TSAS Team will integrate the TSAS underwater tactile system with:

- HRLMD to provide subsurface navigation information.
- Global Positioning System (GPS) for EX 8 Marine Mammal System (MMS) operations, surface swimming and continued operation into the craft landing zone (CLZ)

The interface products will be unobtrusive, rugged, and intuitive to operate, require minimal maintenance and be field tested by operators to refine and optimize the software algorithms.

WORK COMPLETED

FY 2000

- Completed all hardware for the EX 8 and HRLMD platforms. The software algorithms for both platforms have been developed and are currently awaiting opportunities for in water testing and validation. Test dates are dependent upon completion of the HRLMD.
- Multiple demonstrations have been presented at conferences including SOLIC and "command performance" for the Assistant Secretary of the Navy for Research, Development, and Acquisition (ASN(RDA)). ASN(RDA) selected TSAS as one of the five most promising Navy technologies, which was presented to a congressional committee during March 2000.

FY 1999

- Convened an interactive Concept of Operations (CONOPS) meeting with VSW MCM Detachment during February 1999. Discussed past and potential applications of TSAS. Divers experienced the tactile navigation concept via computer simulation. Collected valuable operational details and diver recommendations. The dive platoon and the Marine Mammal Systems platoon endorsed the use of tactile displays. Following a user input meeting, a baseline CONOPS document was completed.
- Demonstrated tactile navigation concept through computer simulation at the INSS IPT on 10 February 1999.
- Completed hardware design for INSS and EX 8 tactile interface. Selected computer processor (Motorola MC68HCIIP2) and determined system architecture for INSS and EX 8 TSAS electronics. Rejected the first choice processor as magnetically unacceptable. Selected processor should provide long-term platform without significant electronic or software redesign. Initiated investigation into underwater radio for wireless link and tested the feasibility of multiple underwater radio configurations. Currently, selecting the basis for wireless communications. Initiated software development for INSS and EX 8 tactile interface navigation algorithms. Developed computer simulations for human factors trade-off for INSS and EX 8 tactile interfaces and developed acceptance criteria and performance metrics.

RESULTS

As part of this program, a VSW MCM simulator with visual and tactile displays has been developed. This simulator is being used for: 1) training of the detachment members in using the tactile display; 2) rehearsal of VSW MCM Test Detachment members for mine clearing and navigation scenarios; and 3) development of the operational hardware. The VSW MCM simulator consists of a visual workstation, an input device, and a TSAS tactile display. The visual workstation simulates the surface or sub-surface visual scene, including realistic mines and the visual display and simulated sensor data of the navigation/sonar sensor. The TSAS display used in the simulator is a slightly modified version of the operational TSAS display. The only modification is to accept the simulated sensor data as opposed to real sensor data. The actual operational TLS is used for the simulator. The simulator provides tactile stimuli to an operator in an identical manner to the operational tactile display, thus, dramatically

improving the training transfer from simulator to real world. Use of the VSW MCM simulator reduces the time required for a diver to learn to use the emerging technology of tactile displays in a mine-clearing environment. Duplicating, rather than simulating, the tactile information in the VSW MCM simulator enhances the rehearsal and training capabilities of this simulator. Using tactile information in both simulation and real world scenarios, divers report reduced workload for navigation. This increases mission effectiveness by allowing them to concentrate more on locating mines.

The endorsement of the VSW MCM Detachment for the use of tactile displays enabled the development of the CONOPS and the final hardware and software configuration.

IMPACT/APPLICATIONS

Tactile displays developed for the VSW MCM Detachment will be transferred to all U.S. Navy underwater activities including BOD and salvage operations. Lessons learned from tactile displays developed for the VSW MCM Detachment will assist in the development of tactile displays for aviation, medical, and communication applications. Additional lessons learned and hardware and software designs developed for the VSW MCM Detachment have assisted in the development of an aviation tactile display for the Marine Corps and Air Force Special Operations Command.

PUBLICATIONS

Rupert, A.H., 2000. Tactile Situation Awareness System: Proprioceptive Prostheses for Sensory Deficiencies, Aviation, Space, and Environmental Medicine, Vol 71, No. 9 Section II, September.